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changes in the soma. However, they are the species as we have them and it seems a hopeless task to go through the animal kingdom and sort the named forms into "ontogenetic" species and "orthodox" species. We shall probably be forced to recognize that the names we give are merely convenient shorthand descriptions of certain organisms, some of which are extremely stable as to form and coloration, others not so much so. Our problem is, then, to find out as much as we can about the causes which bring about the differences which we note.

A new journal, *Zeitschrift für Induktive Abstammungs- und Vererbungslehre,* has just been started. With Baur, Correns and other authorities as editors, much is to be expected of it.

FRANK E. LUTZ.

LITERATURE

1. 1907. Bachmetjew, P. Experimentelle Entomologische Studien vom physikalisch-chemischen Standpunkt aus. Zweiter Band. Einfluss der äussern Faktoren auf Insekten. xcvi + 944 pp. with 25 plates. Sophia.
2. 1908. Federley, Harry. Uber den Albinismus bei den Lepidopteren. *Acta Societatis pro Fauna et Flora Fennica,* XXXI, No. 4.
3. 1908. Marchal, P. Comptes rendus Soc. de Biologie, July. LXV, No. 24.
4. 1907. Powers, J. H. Morphological Variation and its Causes in Amblystoma tigrinum. *Studies from the Zoological Laboratory, the University of Nebraska,* No. 71. 77 pages with 9 plates.

EXPERIMENTAL ZOOLOGY

The Influence of the Size of the Egg and Temperature on the Growth of the Frog.[1]—What determines the difference in size of two animals? It is the difference due to greater or less number of cells, or, perhaps, to a difference in the size of their cells? Does the animal grow by adding more new cells, or by increasing the old cells? These are some of the problems which confront the student of the phenomenon of growth in the animal and plant kingdom alike.

The paper, the subject of this review, contains an account of experiments which attempt to throw light upon these problems.

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[1] Einfluss der Eigrösse und der Temperatur auf das Wachsthum und die Grösse des Frosches und dessen Zellen. Von Robert Chambers, *Arch. für Mikroskopische Anatomie und Entwicklungsgeschichte,* Vol. 72, Part 3, pp. 607–661, 1908.

Chambers experimented with eggs of *Rana temporaria* and *R. esculenta,* and his object was to determine how the initial size of the eggs and temperature affect the size of developing embryos. He found that the eggs of both species show considerable variations in size, that are in no way connected with the prevailing temperature of the locality from which those eggs are collected. The average size of eggs varies not only with the species or locality, but also with each individual frog. Furthermore, eggs laid by one frog also present variations in size, which, in one case, were 1.8 mm., 1.2 mm., 1.15 mm., and 1.05 mm. in diameter. The eggs measuring 1.15–1.20 mm. were most abundant.

Contrary to what one might expect, there is no relation between the size of frogs and the size of eggs which they lay, and small frogs with large eggs as well as large frogs with small eggs are frequently found.

In the first place Chambers undertook to determine the relation of the size of an egg to the rate of its development and subsequent growth of the embryo. He divided eggs of a single frog into lots according to their sizes, and found, on rearing those, that small eggs have a tendency to develop slightly faster than large eggs. This tendency is marked only in the early stages, for as the tadpoles commence to feed those developing from large eggs grow faster and pass through metamorphosis sooner.[2] On rearing eggs of two lots, one containing eggs of large and uniform size, the other containing eggs of various sizes, it was found that the size of tadpoles varied considerably in favor of the former. Besides, the tadpoles of the first lot have all metamorphosed in course of two weeks, while two months have elapsed before the tadpoles of the second lot had all metamorphosed. There is one point in connection with this experiment on which unfortunately Chambers gives no information, and yet it may alter the conclusion drawn from the experiment. He mentions that there were 70 eggs in the first lot and 100 eggs in the second lot. If the eggs of both lots were distributed in an equal number of dishes there must have been fewer eggs of the large size than of the mixed sizes to each dish. The difference in the rate of development and in the size of tadpoles might have been therefore caused by the more or less crowded condition of the eggs, and not by the large or small initial size of the eggs. In fact, Chambers resorts to this factor of the number of eggs developing in a dish to account for the fact that in experiment with eggs of 1.81 mm. and 1.20 mm. in diameter, the eggs of both sizes developed equally fast. The less crowded condition, he thought, compensated in that case for the small size of the eggs. The question as to whether or not the initial size of the egg is a determining factor in the rate of development seems to me, therefore, still an open question.

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[2] See page 7.

Next, Chambers investigated the influence of the size of the eggs upon development at different temperatures. Eggs of *R. temporaria* of the same size were reared separately under temperatures ranging from 10° to 25° C. He found in this case of *R. temporaria,* which spawns early in the spring, that both large and small eggs develop at low temperatures, but only the large eggs are capable of resisting higher temperatures. On the contrary, in case of *R. esculenta,* which spawns in May and June, all eggs develop well at high temperature (19°–27° C.) and only the large eggs develop at low temperature (10°–12° C.). Chambers therefore concludes that large eggs are more efficient in withstanding extremes of temperature.

He found, furthermore, that when eggs of the same individual are reared, under equal conditions of temperature, eggs larger or slightly smaller than those of normal size (the size of the majority of eggs is considered the normal size) develop to advanced stages, but the extremely small eggs invariably die out while yet in the early stages of development. In a lot of eggs, where the normal size was 1.5 mm. only 8 out of 23 eggs measuring 1.15 mm. in diameter and none of those measuring 1.05 mm. reached an advanced stage. Chambers is strongly inclined to think that there is a set limit to the size of the egg of a given species, beyond which it can no longer vary without losing its power of development. But the failure of abnormally small eggs to develop can also be interpreted differently, since the exceptionally small size may be due to the circumstance that the eggs have not yet attained full maturity.

Chambers states that large tadpoles develop always from large eggs, and that the ratio between the volumes of different eggs is maintained more or less constant during the early stages of development, *i. e.,* the tadpoles are in the same relation to each other, as regards volume, as the eggs from which they have developed.

Regarding the cellular elements of the young developed from large or small eggs, Chambers found from his study of sections of various organs and tissues (lens, ear-vesicle, rectum, epidermis, cartilage, muscle-fibers and blood-corpuscules), that the size of the cells of a tadpole or young frog is in direct relation to the size of the examined individual. This in general agrees with the results from my own work, which I hope to publish in the near future, on the cells of large and small salamanders.

Since, as was shown above, the size of the embryo depends upon the size of the egg from which it develops, Chambers draws the further conclusion that the size of cells of an animal is determined by the initial size of the egg from which it has developed.

In another experiment, where eggs of *R. temporaria* were reared at two temperatures of 10° and 25° C., the tadpoles of the first set (10° C.) metamorphosed two months later than those of the second set (25° C.), but the young frogs developed in the medium with a low temperature (10°) were fully one and one half times as large as those developed at a higher temperature. Whether this large size was due to the low temperature or to the fact that the tadpoles had been growing two months longer before metamorphosing, this point is not made clear. However, on examining cells from the epidermis and rectum Chambers found that the differences in total size of frogs, developed at a high or a low temperature, extend also to their cells, so that large specimens have correspondingly larger cells than small specimens.

But the initial size of the eggs and the temperature of the medium are not the only factors determining the size of the tadpoles and young frogs, because large and small individuals may develop even from eggs of uniform size and under similar conditions of temperature. What has been found in regard to the variations in size of the eggs may of course be also true in case of the sperms, which might thus be a factor determining the size of the young. At any rate, Chambers made an interesting observation that tadpoles developed from eggs of the same size begin to vary only after the supply of yolk has been exhausted and they have commenced to take in food. It is not improbable, therefore, that the variations in size result either from an insufficient amount of food available for some tadpoles, as is the case, for instance, in growing starfishes,[3] or else the tadpoles may consume unequal amounts of food under different conditions of health.

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[3] Mead, A. D. On the Correlation between Growth and Food-supply in Starfish. Amer. Nat., Vol. 34, No. 397, pp. 17–23, 1900.

It is a matter of some interest that Chambers maintains that the cells of large and small individuals developed from eggs of uniform diameter are not of different but of the same size. Thus he leads us to believe, and in fact he states it explicitly at the close of his paper, that the principal factor determining the size of cells of an animal is the initial size of the egg from which it developed.

Without giving mention to some objections to this general conclusion, which might be made on the basis of Chambers' own experiments, I wish to point out that the figures of cells given in the text do not carry conviction, and, so far as I was able to make out, they do not bear out Chambers' contention. In the drawings of cells of blood-corpuscles, epidermis and rectum, which Chambers thinks to be of equal size, I find on careful examination that the cells are different. Of course, actual measurements of the cells could make this matter clear, but, unfortunately, there are no measurements given in the paper.

The introduction to the paper contains a résumé of a few works in one way or another related to the problem. This résumé of facts so widely scattered throughout the literature will doubtless be found useful.

The third part of the paper is devoted chiefly to extensive theoretical considerations and does not therefore come within the scope of the present review.

In conclusion I should like to call attention to some defects of a technical character, which obscure the meaning of the text and frequently confuse the reader. In the explanation to Fig. 1 it is said, for instance, that I marks a culture developed from eggs of similar size, and II marks those developed from eggs of different and not ascertained sizes. But in the text referring to this Fig. 1 it is said that "Kulture II wurde mit Eiern angefangen, welche von gleicher, ausgesuchten Grösse waren." Which of these data, whether those found in the text or in the explanation to the figure, are the correct ones the reader is at loss to know, while the understanding of this point is important. On p. 635 we find reference to Fig. "A" and Aa in text Fig. 2. As a matter of fact this reference was found to apply to Fig. a and a^a in the Text-fig. 5. In Table V in the third column the date of spawning is given as June 5, and the date of the first examination of the developing embryos is June 3.

There is, however, a more vital contradiction in the text. On p. 620 in a discussion of the facts presented in Table I we read: "Die kleineren Eier zeigten eine geringe Neigung sich schneller zu entwickeln." On p. 647 referring again to the Table I we read: "In den Furchungs- und Gastrula-Stadien zeigen die kleinen Eier die Tendenz, sich wenigerschnell zu entwickeln, als die grösseren Eier." And further on, p. 647, and referring again to the Table I, we read: " Da wir nun aber gesehen haben, dass die grossen und kleinen Eier sich gleichgut und gleichrash entwickeln (s. Tabelle 1) etc."

Thus it appears that the small eggs develop somewhat faster, and slower than the large eggs, and just as well as the large eggs!

SERGIUS MORGULIS.

PARASITOLOGY

Cestodes of Birds.—Fuhrmann has recently published (*Zool. Jahrb.,* Suppl. 10, Heft 1) a most valuable monograph on the Cestodes of Birds. He had at his disposal all the material from the great European museums and from the private collections of prominent European helminthologists, so that the work is vastly more valuable than a mere literary revision with studies on limited personal collections. In 1782 Gœze described 14 species of Tænia from birds; in 1819 Rudolphi listed 54 certain and 30 uncertain species, and in 1850 Diesing recorded 81 certain and 28 questionable species. Von Linstow's Compendium der Helminthologie and Nachtrag in 1889 gave references to 230 bird cestodes from 340 host species. In this investigation Fuhrmann had material from 200 more species of birds at his disposal and recorded in all some 500 cestode parasites from them. When one considers that 12,000 species of birds are known and Cestodes have been collected from 540 only, it is clear that many more new forms are to be expected; these are to come most prominently from extra-European lands. North America which Fuhrmann notes as relatively unexplored, will contribute its share and I may add that investigations in this field are already in finished manuscript as studies from my own laboratory.

Some of the general conclusions which Fuhrmann has reached as a result of his 12 years of work in this field are of wide interest. The distribution of cestodes among the various group of birds shows that a given species occurs only in a given group